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60/464123
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
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☑ Additional inventors are being named on the 1 separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max)

A Method and Apparatus for a Data Writing onto and Emulating Magnetic Strip

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 11

☑ Drawing(s) *Number of Sheets* 7

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number

☐ Other (specify)

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Respectfully submitted,

SIGNATURE Moshe Shadmon

Date 04/14/2003

TYPED or PRINTED NAME Moshe Shadmon

REGISTRATION NO. *(if appropriate)*

Docket Number:

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

Docket Number	

INVENTOR(S)/APPLICANT(S)		
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Moshe	Shadmon	Palo-ALto CA

Number 1 of 1

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Monday, April 14, 2003

Dear Commissioner for Patents,

Please find the attached provisional application.

Please mail a confirmation using the attached copy of the provisional form and the enclosed envelop.

Regards,
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Title: A Method and Apparatus for a Data Writing onto and Emulating Magnetic Strip

The present invention is generally in the field of a magnetic strip, such as is used, for example, on a credit card or a transportation ticket that is used in combination with a smart card or a new generation magnetic strip writer. The present invention includes a purely electrical approach for both data writing without the use of moving parts onto a magnetic strip and two additional embodiments for emulation of a magnetic strip, all to be read by a conventional magnetic strip reader.

Background:

The use of plastic cards bearing a magnetic strip for effecting sales, banking, and other diverse transactions is very popular, in part because of the ease with which such cards may be legitimately used to effect these transactions.

A magnetic strip on a card enables the card to be swiped repeatedly in a card reader and convey the digital information stored on the strip to that reader. The information on a magnetic strip is written onto the strip by a magnetic write-head similar to the way digital information is written onto a magnetic tape. Writing onto the magnetic strip requires that the write-head move relative to the strip while generating a variable bipolar magnetic field that represents the data to be stored, and magnetizes the particles along the strip accordingly. The magnetic strip material in the form of a slurry is typically deposited on a card, ticket, or other item in the same way as paint is deposited on a surface. The magnetic particles retain the memory of their last direction of the magnetic polarity until a magnetic field strong enough to overcome the particle's coercive force, changes the polarity to a new direction.

The American National Standards Institute (ANSI) & ISO/IEC has defined standards relating to magnetic strip cards. Some of the published standards relating cards and relating devises can be found in:

http://www.iso.org/iso/en/CatalogueListPage.CatalogueList?ICS1=35&ICS2=240&ICS3=15

The standards for the magnetic strip card is Specified by ISO Standards: 7811-1 through 6, 7812, 7813, and 4909.

A typical magnetic strip is segmented into four channels, three of which are defined for a specific format by ANSI are each is dedicated to a different purpose. These tracks are defined only by their location on the magnetic strip:

Track one contains the cardholder's name as well as account and other discretionary data,

Track two contains the cardholder's account number, encrypted Personal Identification Numbers (PIN), plus other discretionary data. This track is the most commonly used and is read by Automatic Teller Machines (ATM) and credit card checkers.

Track 3 is unique and rarely used.

Most ATM cards follow these standards, but there are many other types of cards (key cards, security cards, copy machine cards, etc.) that do not follow these established standards.

Smart cards refer to cards that typically include embedded input/output interface, memory, and a microprocessor. Smart cards look like standard plastic cards, but are equipped with embedded Integrated Circuit(s). Smart cards can store information, carry-out local processing on the data stored, and interface with external devices. These cards take the form of either "contact" cards that require an electrical connection to an external card interface (Card Acceptance Device) or "contactless" cards that communicate by electromagnetic signals to the external card interface (Card Acceptance Device). The contact card typically has eight metallic interface pads on its surface, each designed to international standards for VCC (power supply voltage), RST (used to reset the microprocessor of the smart card), CLK (clock signal), GND (ground), VPP (programming or write voltage), and I/O (serial input/output line). Two pads are reserved for future use (RFU). Only the I/O and GND contacts are mandatory on a card to meet international standards; the other contacts are optional.

When a smart card is inserted into a Card Acceptance Device or CAD (such as a point-of-sale terminal), the metallic pads come into contact with the CAD's corresponding metallic pins, thereby allowing the card and CAD to communicate. Smart cards are reset when they are inserted into a CAD. This action causes the smart card to respond by sending an "Answer-to-Reset " (ATR) message, which informs the CAD of what rules govern communication with the card and the

processing of a transaction. Additional information about smart card features according to current art can be obtained from available standards and respective literature that are in public domain.

Whatever the advantages of smart cards over magnetic cards, and there are many, the use of smart cards has been relatively slow, especially in the US market. One of the main reasons for their slow adoption is the present lack of support infrastructure, necessitating retrofitting of equipment such as vending machines, ATMs, and telephones.

The standard "non-smart" magnetic strip cards, on the other hand, enjoy a ubiquitous infrastructure in many commercial, access control, and other applications.

There is, additionally, a need in the art to allow efficient "backward compatibility" of smart cards so that information stored in or generated by the smart card is accessible by magnetic card readers. A single smart card substitutes the function of multiple magnetic strip cards and allows the user to easily change the card's identity/function using the smart card's input/output interfaces such as a built-in keyboard and display.

Summary of the invention:

The present invention enables direct writing of information from a smart card's electronic medium onto a magnetic strip. Said magnetic strip is configured by information that was originally stored in the memory of the smart card, and/or was generated by the processor of the smart card, and/or based on information that has been added by the user by means of a keypad configured with the said smart card.

An additional advantage of the present invention is the static writing of data onto a magnetic strip without the need for a moving magnetic head relative to the strip. This constitutes a novel and reliable approach for card writers.

Another advantage of the present invention is a stationary current matrix without moving parts that selects writing to each conductor segment by addressing at least two matrix coordinates utilized by both the smart card and the new generation standard magnetic strip card writer. This matrix minimizes the complexity of the electronic drivers that inject current into each conductor segment.

Yet another advantage of the invention is the ability to emulate a magnetic strip rather then writing onto one.

Yet another advantage of the present invention is the static emulation of a magnetic strip. This feature requires extremely low current when compared with those required for writing data onto magnetic strip material. It is, however, required that the currents be maintained while the card is read.

A yet additional advantage of the invention is the ability to emulate a magnetic strip on a smart card. This novel approach emulates the swiping of a magnetic strip while either swiping the card at any speed or keeping the card motionless in the card reader where the data is conveyed to the reader by a magnetic field generated in real-time by an electromagnetic transducer that is defined as a means of conversion of electrical properties (current and/or voltage) to a magnetic field such as a conductor, solenoid, or coil. For motionless card reading, the smart card is positioned so that the magnetic field generated by the conductor is proximate to the magnetic read-head of a card reader. This method is the most power efficient yet since it reduces the variable signal (such as current) to a single electromagnetic transducer, thus reducing the current used compared to the static emulator by a factor equal to the number of data bits per channel. In addition, it drastically reduces the number of current drivers to one per channel.

A final advantage of the invention is the ability to write onto the smartcard using a conventional magnetic strip writer by virtue of a magnetic coupling of the write head of the magnetic strip writer with the magnetoelectric transducer that is defined as a means of conversion of magnetic field to electrical properties (current and/or voltage) such as a Hall effect device, conductor, solenoid, or coil.

Details Of The Invention:

The present invention comprises three embodiments for achieving digital data transformation into a format that is compatible with the standard magnetic strip reader. All are based on basic principles of magnetism, electric current, and the relationship between them. The three embodiments are:

1. Magnetic imprint on a magnetic strip by current impulse with magnitude and direction control in a conductor proximate to the magnetic strip where said conductor location corresponds to the expected magnetic poles' imprint on the magnetic strip. A conductor

array for imprinting data on a magnetic strip is embedded in the smart card and is external to the card when used as a new generation magnetic strip writer onto standard magnetic strip cards.

2. Static emulation of a magnetic strip by current magnitude and direction control in a conductor retained for the duration of the reading of the emulated magnetic strip where said conductor location corresponds to the expected location of the magnetic poles on the magnetic strip being emulated.

3. Dynamic emulation of a magnetic strip by the current's magnitude control and its direction in a conductor. The current's polarity changes in accordance with the data and at a rate determined to be appropriate for a given magnetic strip reader. This constitutes a variable magnetic field burst corresponding to the data to be delivered to the magnetic strip reader which is repeated, if necessary, at least for the duration of the reading of the emulated magnetic strip.

   An optional feature of this embodiment is the ability to transfer data from a standard magnetic strip writer to the smart card using the same or similar magnetic coupling which in this case is between the write head of the magnetic strip writer and the smart card transducer.

All embodiments are based on the fundamental relationship of current in a conductor (4) illustrated in Fig.1, generates magnetic field (6) of strength H around the conductor (4):

$$H \quad \frac{I}{R}$$

Where: I is the current in the conductor and R is the radius (distance) from the center of the conductor (4) to the location of interest where magnetic field (6) H is measured. The orientation (direction) of the magnetic field (6) H is clockwise as indicated by the arrows on the magnetic field lines (6) and corresponds to a current direction in the conductor (4) that is perpendicular to the page and flows in a direction from the viewer into the page.

An example of the first embodiment is where a thin magnetic strip layer (2) in close proximity to the conductor (4) is affected to assume magnetic polarity of North Pole (N) and South Pole (S) as indicated in Fig.1. When the current direction is reversed in a direction from the page to the viewer,

the direction of the magnetic field is reversed to counterclockwise and so are the S and N polarities on the magnetic strip (not shown). The magnetic field strength (6) must be intense enough to overcome the coercivity of the magnetic strip (2) material. Since the magnetic field is proportional to the current in the conductor (4), it is necessary to reach a balance between the magnitude of the current pulse and the coercivity of the magnetic material. Once the magnetic polarity on the magnetic strip (2) has been set by the current, the current flow can be stopped and the imprint on the magnetic strip will remain in that setting until reversed by a reverse current in the conductor (4) or by an external magnetic field that is strong enough to overcome the coercivity of the magnetic strip (2). Thus, current impulses of the right magnitude and direction are sufficient to imprint data on the magnetic strip material.

It is desirable to minimize the magnitude of the current pulses so that currents and their switching drivers become manageable. However, the lower the coercivity of the magnetic strip material, the more susceptible is the magnetic strip to being inadvertently modified by external magnetic fields.

Fig.2 illustrates a preferred embodiment of a typical card (10) with a four channel (track) (20), (30), (40), and (50) a magnetic strip. The resolution of such a magnetic strip varies and some standards suggest 75 and 210 bits per inch of data density. Fig. 3a provides a view of a segment of one channel of the magnetic strip (70). Items (80a), (80b), and (80c), drawn in dotted lines, represent the conductors in a layer below the magnetic strip (70). The distance between the conductors determines the maximal bit density possible. For example, for a resolution that will accommodate 210 bits per inch, at least 210 conductors per inch must be constructed.

Fig.3b illustrate the cross-section AA of Fig. 3a in which (80a), (80b), and (80c) are the conductors with insulating material (75) between them while on top of them is located the magnetic strip (70).

Fig.3c illustrates the cross-section BB of Fig. 3a in which the leads (82a) and (82b) are made available for connections between the conductor (80c) and a current delivery and switching drivers.

The embodiment described above is suitable for integration with a smart card whereby internal current drivers are included in the electronic systems of the smart card. These drivers deliver the currents necessary to write and rewrite the data content of the smart card's magnetic strip. The smart card's direct writing is initiated by external command inputs to the smart card or by, for example,

stroke(s) on the card's keyboard. Subsequently, when the smart card is swiped in a standard magnetic strip reader, the last data written will be available to the reader.

Another example to the first embodiment of the present invention illustrated in Fig. 3a, Fig. 3b and Fig. 3c, where a magnetic strip (70) is part of, for example, a standard credit card, whereas the conductors (80a), (80b), and (80c) as well as the insulator (75) are part of a new generation static magnetic strip writer. The new generation magnetic strip writer will also consist of the appropriate electronics and current drivers. Such a magnetic strip writer requires that the object bearing the magnetic strip (70), such as, for example, a credit card, be placed in close proximity to the conductors (80a), (80b), and (80c) as seen in Fig. 3b. While the magnetic strip is kept in a stationary position relative to the writer, currents through the conductors (80a), (80b), and (80c) induce the data information onto the strip. Such a magnetic strip writer is more reliable than the current art that has either moving card or moving magnetic write-head. The new write approach will also write faster than conventional writers.

Fig. 4a, Fig. 4b and Fig. 4c represent yet another example of the first embodiment of the present invention. The drawings are equivalent to Fig. 3a, Fig. 3b and Fig. 3c except that the magnetic strip material is in the layer underneath and between the conductors. The results are very similar to the first embodiment but the resulting polarity is reversed as evident in Fig. 5. Fig. 5 illustrates how the card reader will read the magnetic field (6) at the air gap (8) with the North Pole (N) to the left and the South Pole (S) to the right of the conductor.

It is understood that the preferred embodiment described above is an example of one of many configurations of a conductor proximate magnetic strip material for the purpose of writing data onto the magnetic strip which are within the scope and the spirit of present invention.

The switching mechanism of pulsed current in selectable directions into each individual conductor embedded in the magnetic strip has been used in prior art in conjunction, for example, with magnetic core memory and will therefore not be elaborated on in this specification.

Fig. 6 illustrates that using two substantially proximate conductors assigned to each bit, allows selection of each bit by the sum of currents in the two conductors. Therefore, the sum of two currents flowing in the same direction is designed to overcome the coercivity of the magnetic strip for each bit, whereas each current alone or opposing currents will not. In Fig. 6, current through lines

y2-y2 and x6-x6 that add together to become a higher current at bit (100) is an example of such matrix bit selection. This approach is akin to the selection process of a single core in a magnetic core memory and allows the selection to be accomplished in the form of a matrix and consequently uses fewer current drivers.

Fig. 7 illustrates how a conductor (104) generates a magnetic field (106) at the air gap (108) where the orientation (direction) of the magnetic field (106) H is clockwise as indicated by the arrows on the magnetic field lines (106) and corresponds to a current direction in the conductor (104) that is perpendicular to the page and flows in the direction from the viewer into the page.

Fig. 8 illustrates how a conductor (104) that is partially surrounded by ferromagnetic material (102) generates a magnetic field (106) at the air gap (108) with the North Pole (N) to the left and the South Pole (S) to the right of the conductor (104).

The second embodiment of the present invention consists of static magnetic strip emulation. This embodiment does not comprise any magnetic strip material. Instead, a set of conductors (180a), (180b), and (180c) shown in Figs 9a, 0b, and 9c are embedded in a nonconductive material (170) proximate the surface of the smart card's enclosure spaced corresponding to the data poles on the emulated magnetic strip. Such a conductor set must correspond to at least one of the channel tracks (20), (30), (40), and (50) of the magnetic strip in Fig. 2. Current flowing in each of these conductors in directions that correspond to the data bits being emulated, generate a magnetic field along each track that can be read by a magnetic strip reader. Further more, because the magnetic field generated need only be read by a sensitive read head of the magnetic strip reader and is not required to overcome the coersivity of magnetic strip material, the currents required are very low. This is a significant advantage to the first embodiment in a battery-operated smart card and greatly simplifies the current drivers. However, it comes at the cost of having to sustain the currents during the reading process.

The third embodiment comprises a dynamic emulation of a magnetic strip and the act of swiping. Fig. 10 illustrates the third embodiment of a smart card (110) where the four track (channel) magnetic strip has been substituted with four electromagnetic transducers such as sections of conductors (120), (130), (140), and (150) configured with at least one of surrounding ferromagnetic material as shown in Fig. 8 and without the ferromagnetic material as shown in Fig. 7. The card is

placed in a conventional magnetic strip reader in a manner that brings the conductors (120), (130), (140), and (150) proximate the reading head of the reader. The smart card emulates the swiping action of a magnetic strip by generating the same varying magnetic field as that of a magnetic strip being swiped in the vicinity of the read-head. The varying magnetic field is induced by an electromagnetic transducer such as a conductor and is controlled by the transducer's driver in the direction and intensity of the current. For four magnetic strip channels, four such transducers (120), (130), (140), and (150) and drivers are used. In addition, a conventional magnetic strip writer conveys data to the smart card using the magnetic coupling between the write head and the transducers (120), (130), (140), and (150) of Fig. 7.

Another example of this embodiment is disclosed because of the act of swiping the cards in conventional magnetic strip readers. In order to provide the same information to the reader while the smart card is being swiped, a magnetic field representing the data must be present along a longer segment of the smart card mimicking the same location where a standard magnetic strip would be placed. Fig. 11 illustrates a single track of elongated magnetic field generated by an electromagnetic transducer such as a solenoid/coil (260) that is equivalent to multiple conductors with current flowing in the same direction through them. The resulting magnetic field (206) can be adjusted to certain boundaries by the use of ferromagnetic material as at least one of a core of the solenoid/coil and external to the solenoid/coil. This may be necessary to separate the magnetic fields of two adjacent tracks. Fig. 12 illustrates a four track (channel) (220), (230), (240), and (250) electromagnetic transducer based smart card (110). The advantage of this embodiment over the second embodiment is that it exhibits even greater current savings and further reduces the number of current drivers. The current consumption is reduced because the data is presented sequentially i.e. no more than one bit is generated at a time compared to all the bits generated simultaneously in the second embodiment. In addition, a single current driver per track is required in the third embodiment compared to one driver per data bit in the second embodiment.

This embodiment also allows a conventional magnetic strip writer to convey data to the smart card using the magnetic coupling of the write head with the four track (channel transducers) (220), (230), (240), and (250) (see Fig. 12). These transducers are compatible with a conventional magnetic strip reader and writer for two-way data transfer to and from a smartcard.

Claims

We claim:

1. A method of writing digital data onto a magnetic strip comprising:
   a conductor placed proximate the magnetic strip;
   a driver for sending current through the conductor; and
   a current direction control through the conductor.
2. The method of claim 1 where a plurality of conductors determines the data density on the magnetic strip.
3. The method of claim 1 where a plurality of conductors per data bit are interconnected to form a matrix where only the composite current of all conductors assigned to a selected data bit is large enough to imprint the data onto the magnetic strip.
4. An apparatus for writing digital data onto a magnetic strip comprising:
   a conductor proximate the magnetic strip;
   a reversible current source for driving the conductor; and
   a data controlled current director.
5. The apparatus of claim 4 where the proximity between a plurality of conductors determines the magnetic strip's resolution.
6. The apparatus of claim 4 where a plurality of conductors per each data bit are interconnected to form a matrix for optimizing the number and capacity of current drivers.
7. A method of emulating a magnetic strip comprising:
   a conductor proximate the card surface for each bit;
   a conductor current driver with current direction control; and
   a current flow in the conductor for generating a magnetic field for data representation at least while the card is being swiped for reading.
8. An apparatus for emulating a magnetic strip comprising:
   a conductor array proximate the card surface in the location designated for magnetic strip tracks;
   a conductor current driver with current direction control; and
   a current flow in the conductor for generating a magnetic field for magnetic strip data representation at least while the card is being swiped for reading.
9. A method of emulating a magnetic strip being swiped at a magnetic strip reader comprising:
   a conductor placed on a smart card;

a driver for sending current through the conductor; and

a current direction control through the conductor as a function of time.

10. A method of claim 9 where an elongated magnetic field is generated by an electromagnetic transducer converting electrical property to a magnetic field such as a conductor, coil, or solenoid.
11. A method of claim 9 where at least one of a conductor, a coil and a solenoid transducer is magnetically coupled with a write head of a magnetic strip writer for entering data to the smart card.
12. A method of claim 11 where the transducer is a Hall-effect device.
13. An apparatus for emulating a magnetic strip being swiped at a magnetic strip reader comprising:

    a conductor placed proximate the surface of a smart card;

    a driver for sending current through the conductor; and

    a current direction control through the conductor as a function of time.
14. An apparatus of claim 13 where an elongated magnetic field representing a data track is generated by an electromagnetic transducer.
15. An apparatus of claim 13 where a transducer receives data from a conventional magnetic strip writer using magnetic coupling of the writer with the smart card.

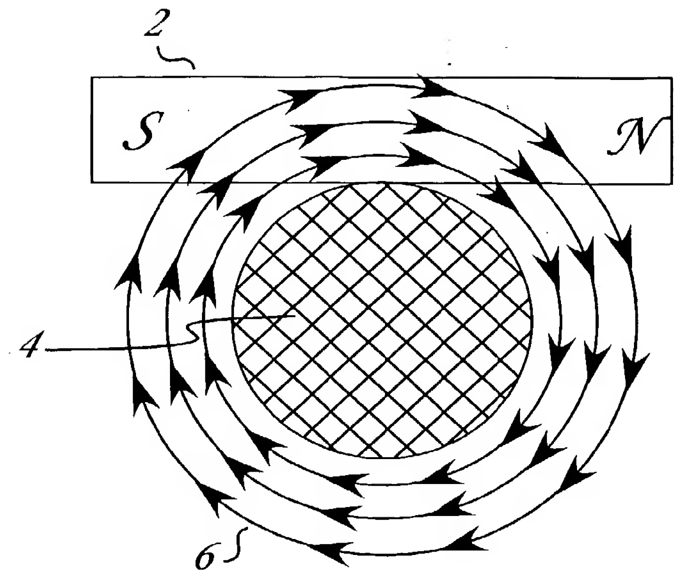


Fig. 1

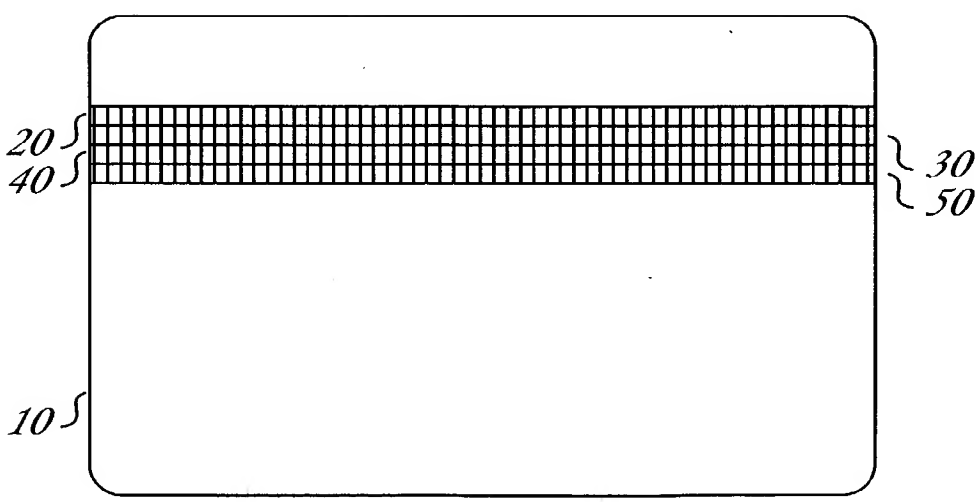


Fig. 2

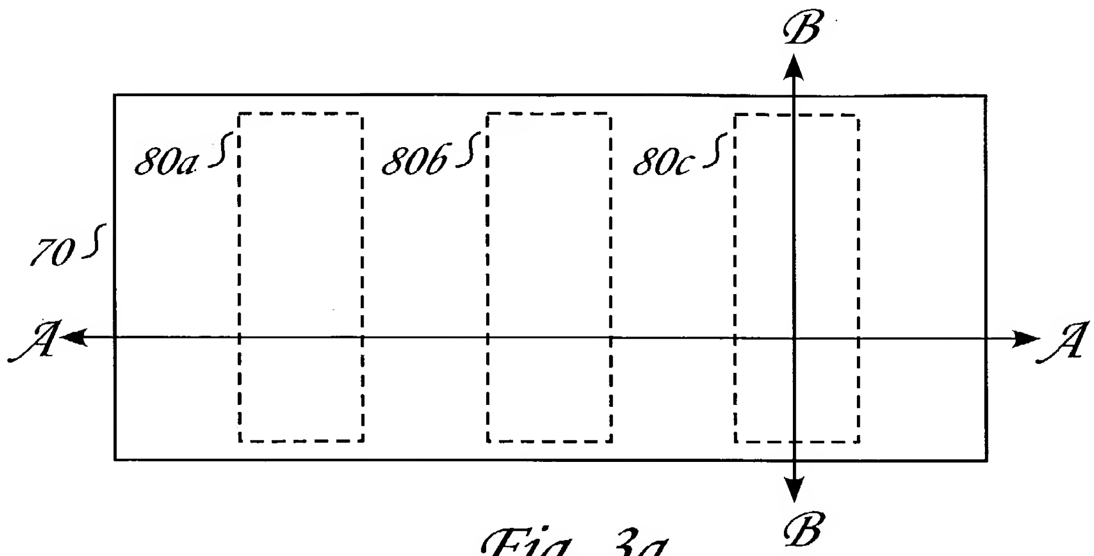


Fig. 3a

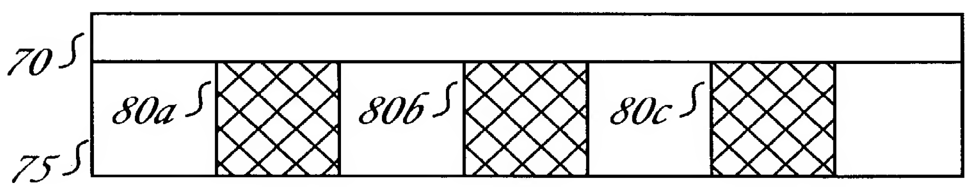


Fig. 3b

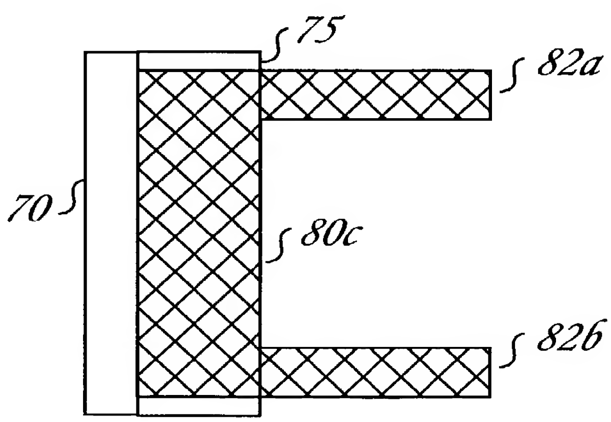


Fig. 3c

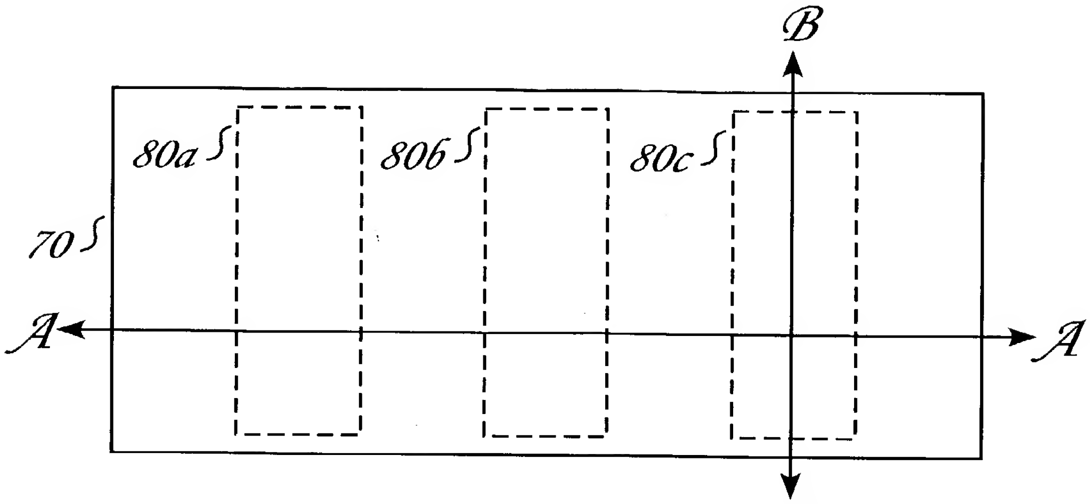


Fig. 4a

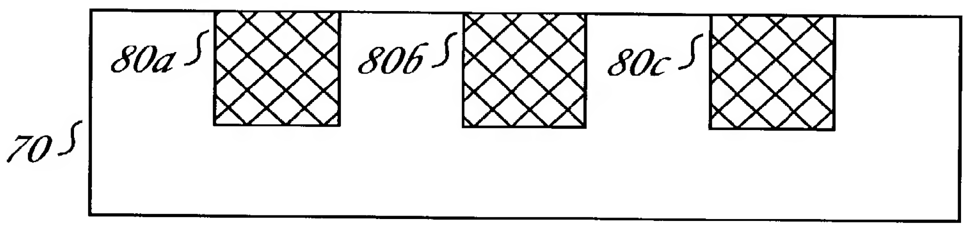


Fig. 4b

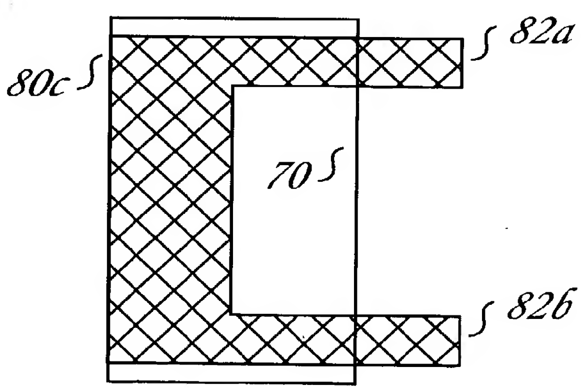
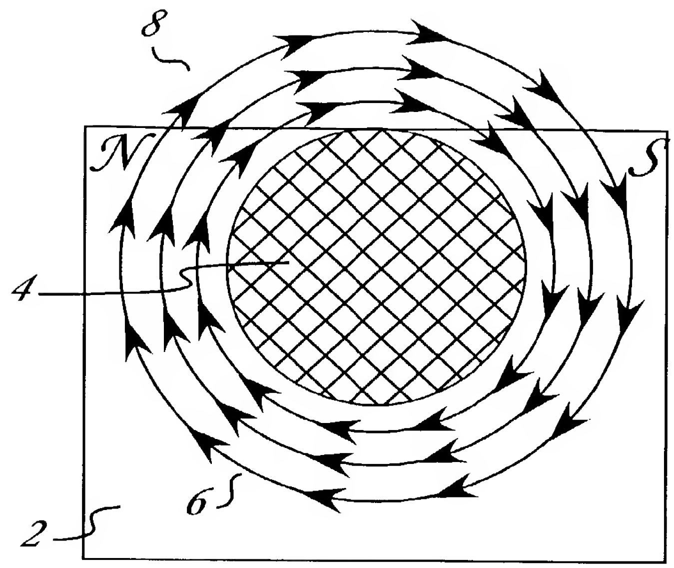


Fig. 4c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N
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Fig. 5

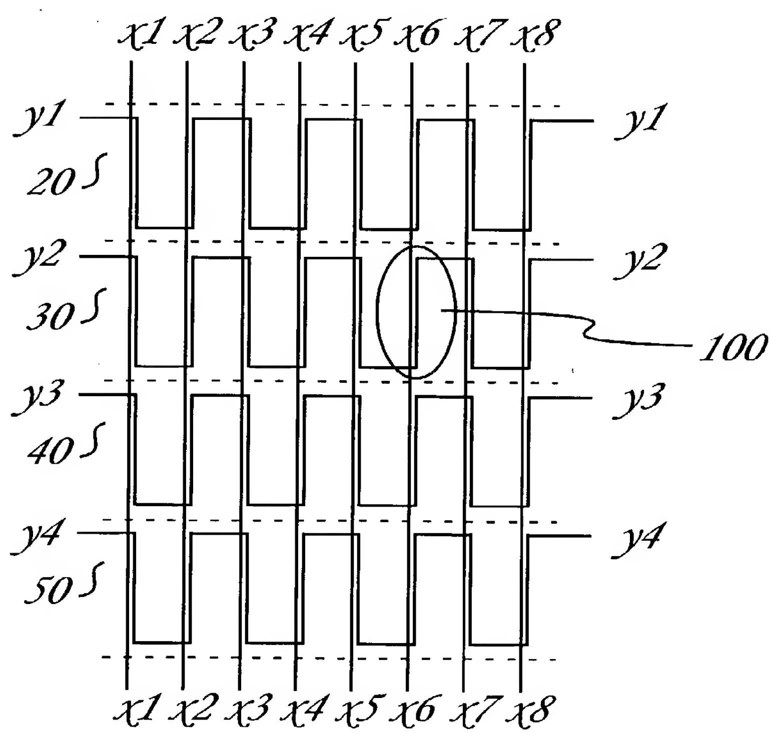
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Fig. 6

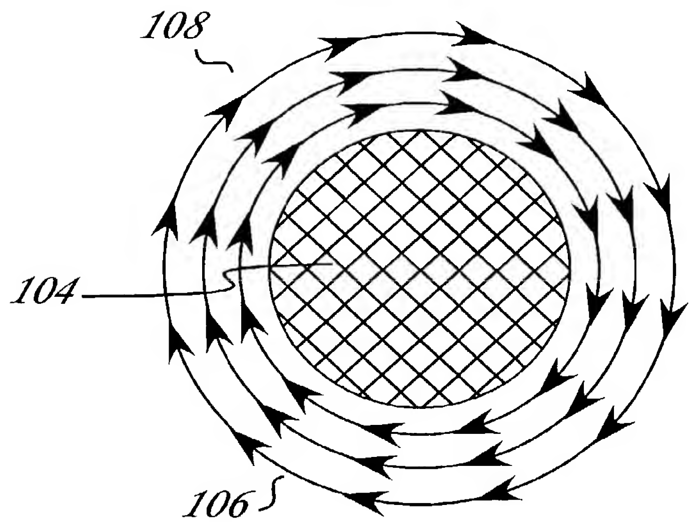

Fig. 7

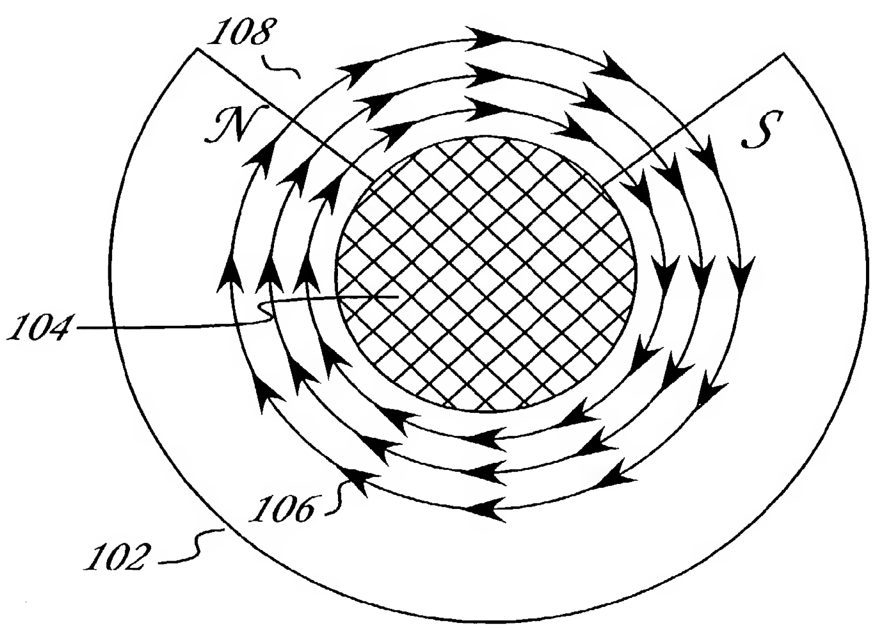

Fig. 8

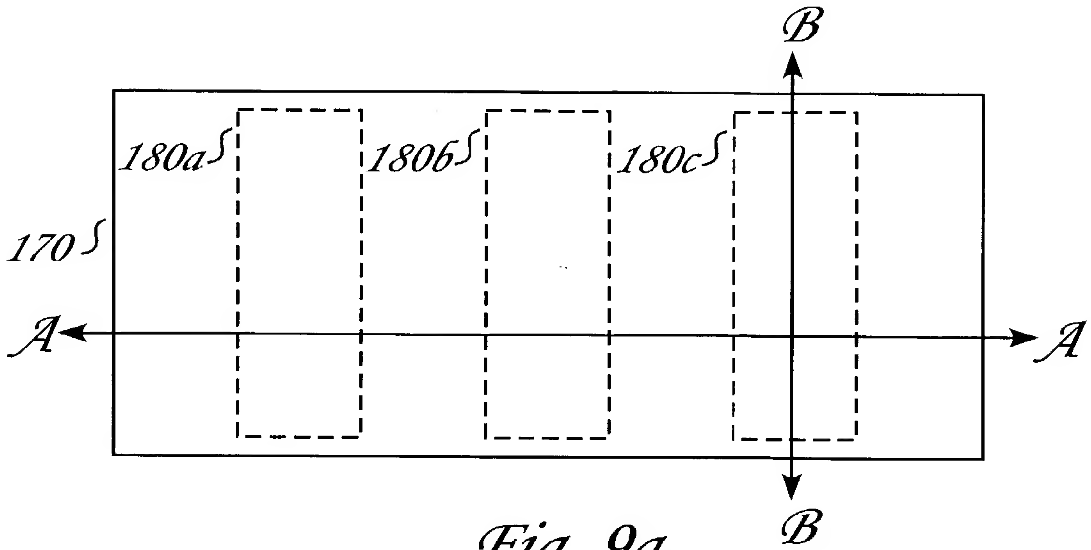

Fig. 9a

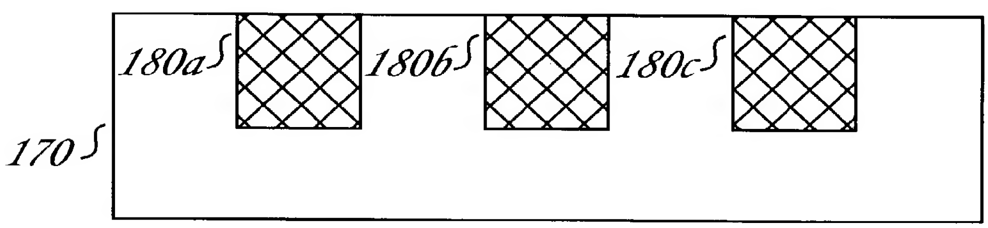

Fig. 9b

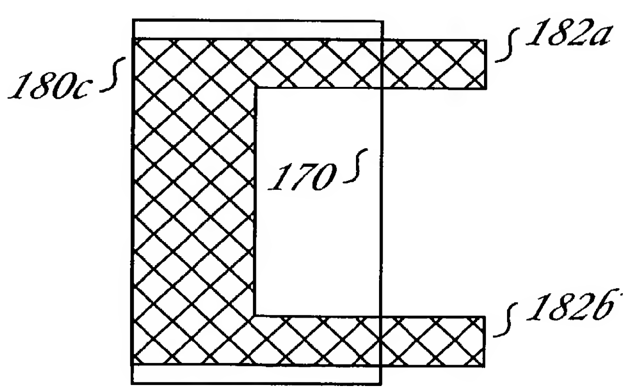

Fig. 9c

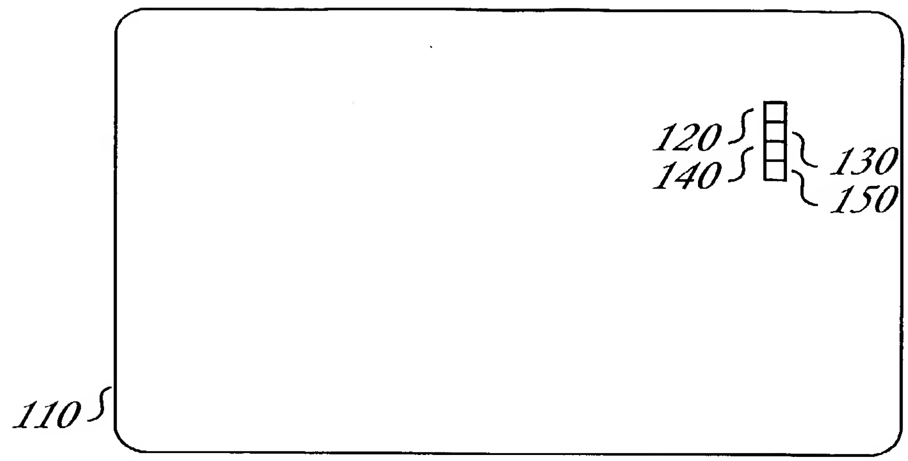

Fig. 10

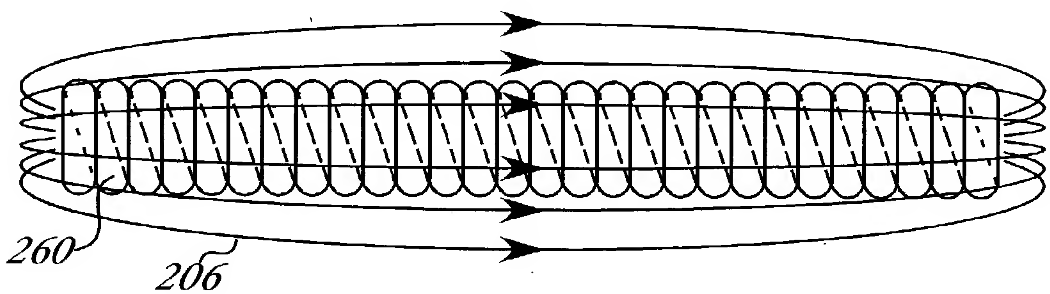

Fig. 11

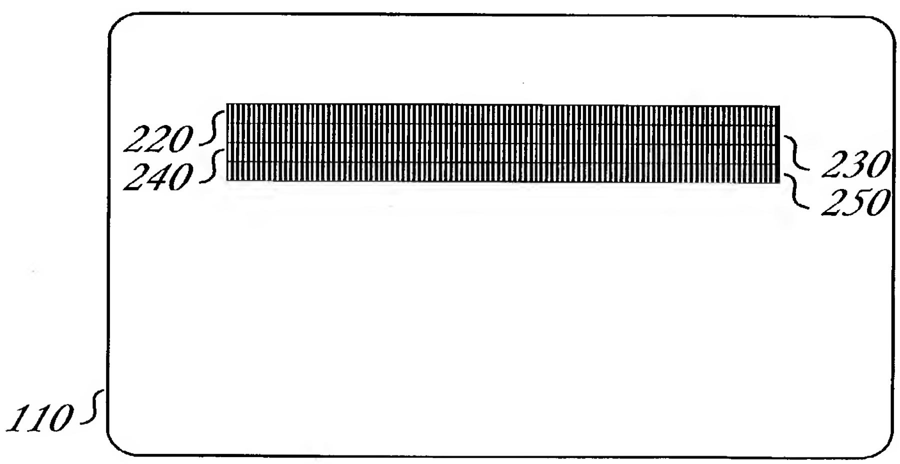

Fig. 12